IAU SYMPOSIUM PROPOSAL

1. Title: **Multi-Wavelength Investigations of Solar Activity**

2. Date &duration: **June 21-25, 2004, 5 days**

3. Location: **St.Petersburg, Russia**

4. Coordinating IAU Division: **II. Sun and Heliosphere**

5. Proposing Commission: **12. Solar Radiation and Structure**

6. Supporting Commissions: **10, 49**

N .B.: Letters from the Presidents of the relevant IAU Commissions must accompany the proposal.

7. Other ICSU body co-sponsoring the meeting, if any:

8. Other supporting organizations, if any: **ESA, NASA**

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10. Proposed Scientific Organizing Committee (identify *Chairman* or *Co-chairmen* with an *) *(up to ten)*

Name	Country	Name	Country
G. Ai	China	A.G. Kosovichev	Ukraine/USA
E.E. Benevolenskaya*	Russia/USA	A.V. Stepanov*	Russia
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12. Proposed Editors of the Proceedings (identify the *Chief Editor* with an *):

Name	E-mail
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Proposed Publisher: Kluwer Academic Publisher

13. Expected or maximum number of participants: 200

14. Registration fee

Amount in USD	__180____	Equivalent amount in CHF	_____
Expenses covered (in USD):			
Transportation airport / hotel	__30_____	Transportation conference / hotel	__30_____
Coffee breaks	__20_____	Proceedings	__60_____
Any other items			
Conference services - 40			

15. Expected price of 2-3 available categories of hotels and / or other accommodations:

$20-30 (Pulkovo Hotel), $30 – $100 (St.Petersburg Hotels)

16. Amount requested for travel support from the IAU *(Fixed amount: 25,000 CHF):* 25,000 CHF

17. Preliminary Scientific Programme Topics (*For announcement in the IAU Information Bulletin) (*max. 10 lines):

The recent advances in observations of the Sun have opened a unique opportunity for multi-wavelength investigations of solar phenomena of various spatial and temporal scales, such as subphotospheric plasma flows and structures, sunspots and active regions, coronal loops and holes, magnetic reconnections and mass ejections in the corona and heliosphere. Understanding the links among these phenomena in different layers of the Sun is a key to understanding the mechanisms of solar activity. The goal of this symposium is to explore these links in different temperature and density regimes using the tremendous amount of observational data available in the whole range of wavelengths, from acoustic and radio waves to X-rays. The symposium will review the most recent results from the space missions (SOHO, TRACE, CORONAS, RHESSI, YOHKOH), and ground observatories. It will also discuss the current theories of solar dynamics and activity, new constraints provided by the multi-wavelength observations, and future coordinated plans and efforts of multi-wavelength investigations of the Sun.

Please append a detailed and draft programme.

18. We confirm that attendance from ALL countries is guaranteed, in accordance with the ICSU Rules on Freedom in the Conduct of Science (see note on Unrestricted participation in IAU sponsored meetings, and describe steps taken to this end): Symposium and Colloquia will be open to all who are qualified to participate, with no restriction based on sex, race, colour, nationality, or religious or political affiliation.

19. Signatures

Proposer (SOC chairperson)			
Name	Date	Place	Signature
E. E. Benevolenskaya A. V. Stepanov			

President of Proposing or Coordinating IAU Division			
Name	Date	Place	Signature
A. O. Benz			

Scientific Rationale

The recent advances in observations of the Sun from ground-based and space observatories have opened a unique opportunity for multi-wavelength investigations of solar phenomena of various spatial and temporal scales. These include evolving plasma flows and structures inside the Sun, magnetic and convective structures in the solar photosphere, topology and dynamics of coronal loops and holes, fast reconnections and mass ejections in the corona and heliosphere. Understanding the links among these phenomena is a key to understanding the mechanisms of solar activity.

Traditionally, solar physics has been developed as a series of disciplines with little interaction among them. However, the recent results reveal amazing links between the solar phenomena at very different physical condition and temporal and spatial scales. It becomes more and more apparent that for understanding the physics of solar activity it is necessary to develop a synthesis of the various solar disciplines, such as helioseismology, the dynamo theory, physics of sunspots and active regions, magnetohydrodynamics of eruptive filaments and prominences, and various aspects of the coronal physics.

The symposium will focus on the most fundamental problems of solar activity the solution of which requires cross-discipline investigations and discussions, and will include the following topics:

1. Solar cycle in the interior, atmosphere and heliosphere
2. Structure and evolution of active regions from the sub-photospheric layers to the corona
3. Formation and instabilities of filaments and prominences and their relationship to the evolution of the global magnetic field
4. Multi-scale chromospheric and coronal structures and their coupling with the photospheric magnetic fields and dynamics.
5. Energy transport, storage and release in the solar atmosphere and corona
6. Heliospheric effects of solar activity and space weather forecast

A new emerging concept is that the plasma processes in the solar interior, atmosphere and corona are strongly coupled and interdependent. The recent discoveries of the strong correlation between the coronal inflows and the non-axisymmetrical quadrupole component of the photospheric magnetic field, and the giant coronal loops changing the topological structure of the Sun's global field, suggest that the coronal processes may play an active role in the mechanism of the solar cycle. The traditional view of the solar cycle that it is entirely determined by the solar dynamo deep in the convection zone and magnetic flux transport at the surface has to be reconsidered. The recent development of theoretical and numerical models of the solar dynamo and emerging flux has also led to new ideas that large- and small-scale helical coronal ejections play an important role in the solar cycle, helping to prevent the cycle from quenching and enabling a net magnetic flux change in each hemisphere. Therefore, it is important to discuss the existing observational data concerning the development of the solar cycle in the interior, photosphere and corona, new theoretical ideas and how to test them, and how to incorporate the new data and ideas into global models of the solar cycle.

These tasks are closely related to understanding the formation and evolution of the basic solar structures: sunspots and active regions. The key questions are how the active regions emerge, grow and decay, why the magnetic field becomes strongly concentrated in the form of sunspots, what determines the preferred latitudes and longitudes for complexes of activity, how the new emerging flux and evolution of active regions affects the magnetic structure of the corona, what is the origin of magnetic twists and how the magnetic helicity is transported into the corona and heliosphere. Recent advances in solar instrumentation has allowed us to observe the sunspot structure in the photosphere with a very high resolution of 0.1-arcsec (70 km), thus providing the opportunity to study the structure and dynamics of the basic building blocks of solar magnetism. On the other hand, the rapidly developing methods of local helioseismology have provided a look at the internal structure of sunspots and associated flows. Thus, an important task of this Symposium is to discuss the current knowledge of the structure and evolution of active regions, sunspots and associated structures from the sub-photosphere to the corona, and investigate MHD links at different layers.

This leads to the multi-wavelength investigation of filaments and prominences, the major sources of the mass and helicity ejections into the corona and heliosphere. It has been known for a long time that filaments and prominences are formed along the magnetic neutral lines that separate large-scale magnetic areas formed by active regions, their remnants, and also by the polar field. They can be very long, comparable with the size of the Sun, and accumulate a tremendous amount of relatively cool plasma. The filament can suddenly erupt, and these eruptions result in restructuring of the large-scale fields. They are sources of major solar disturbances and a very significant element of the global dynamics of the Sun. However, many important questions remain unanswered. How are the filaments formed? Can the photospheric magnetic and flow fields in the filament regions explain their structure and evolution? What are the characteristics of the pre-eruptive state? What can we learn about the initiation mechanism from the high-resolution coronal observations of the structure and dynamics of eruptive filaments? What is the role of filament eruptions in the restructuring and solar-cycle evolution of the global magnetic field?

The fundamental property of solar phenomena is their multi-scale structure and dynamics. This is most clearly observed in the solar corona where the global-scale restructuring may occur in a matter of hours. However, it is believed that the fast reconnection and dissipation of solar magnetic fields may happen only on a very small scale. What controls the large-scale organization of coronal dynamics? Is there a relationship between the sub-photospheric dynamics and large-scale coronal structures, coronal holes, arcades, filaments? How do small-scale structures in the photosphere and corona interact? There is continuous microflaring in the small-scale network field accumulated by emerging bipoles at the boundaries of supergranular cells, which is accompanied by myriads of tiny jets and explosions in the transition region. In weak field regions, it appears to be the principal source of coronal heating, and, perhaps, the fast solar wind.

Multi-wavelength observations in the solar corona with high spatial and temporal resolution have revealed fine-scale filamentary structure of active region loops, and provided evidence that the huge amount of energy released in solar flares appears to be a cumulative effect of unresolved nanoflares. Yet, the most powerful flares are observed in long-living complexes of activity associated with preferred longitudes and, thus, are related to the organization of the large-scale field. What determines the conditions for strong solar flares? Is it possible to predict the accumulation of mass and energy by observing the photospheric magnetic and flow fields? What is the role of magnetic helicity in these processes?

The discussion of these key questions of solar physics will be based on the tremendous amount of observational data obtained from the highly successful space missions, SOHO, YOHKOH, TRACE, CORONAS-F, RHESSI, ULYSSES, and ground-based observatories. The importance of coordinated multi-wavelength investigations is convincingly demonstrated by more than 160 Joint Observing Programs organized by the SOHO team during the past 8 years. This symposium will provide a forum for a

discussion of the most successful of them. The symposium will also discuss future coordinated plans and efforts of multi-wavelength investigations of the Sun.

Understanding the basic mechanisms of solar activity is the ultimate challenge to astrophysics. The solar studies have demonstrated that the nature of observed magnetic activity on the Sun, and thus, in the rest of the Universe, cannot be deduced from first principles. This understanding can be developed only through a synergy of multi-wavelength observations of the solar interior and atmosphere, and theoretical analysis and modeling of these observations. The proposed symposium will make an important step in this direction.

Sample Scientific Programme

1. Solar Cycle in the Interior, Atmosphere and Heliosphere

- New Constraints on the Solar Dynamo from Helioseismology (P. Gilman)
- Observations of the Solar-Cycle Evolution of the Interior Dynamics (T.L. Duvall, Jr.)
- Impulses of Solar Magnetic and Coronal Activities (E. Benevolenskaya)
- Solar-Cycle Variations of Magnetic Helicity (S.D. Bao)
- Torsional Oscillations in Solar Photosphere, Chromosphere and Corona (A.G. Tlatov)
- Polar Activity Cycle and Magnetic Field Reversal (V.I. Makarov)
- Links between the Coronal Dynamics and Sector Magnetism (N. Sheeley)
- Helical Coronal Ejections and Their Role in the Solar Cycle (A. Brandenburg)
- Theories of Solar and Stellar Magnetic Field Cycles (L.L. Kitchatinov)

2. Structure and Evolution of Active Regions from the Sub-photospheric Layers to the Corona

- High-Resolution View of Sunspots (G.B. Scharmer)
- Internal Structure and Dynamics of Sunspots and Active Regions (D.C. Braun)
- Plasma Motions in Magnetic Fields of Sunspot Umbrae (O.S. Gopasyuk)
- Sunspot Oscillations and Velocity Field in the Transition Region and Corona (P. Maltby)
- Structure, Dynamics, and Energetics of Active Region Moss (B. De Pontieu)
- Radio Magnetography of Solar Active Regions (G.B. Gelfreikh)
- Magnetic Twist of Active Regions (M. Lopez Fuentes)
- MHD Models of Sunspots (T. Bogdan)

3. Formation and Instabilities of Filaments and Prominences

- Filament Flows (O. Engvold)
- Photospheric Magnetic and Velocity Fields Near the H-alpha Filaments (B.Ioshpa)
- Multi-Wavelength Spectro-Polarimetric Diagnostics of Prominences and Filaments (B. Schmieder)
- Pre-Eruptive Filament Structures (S.F. Martin)
- Active-Region Filaments and X-ray Sigmoids (A. Pevtsov)
- Structure and Dynamics of Eruptive Filaments in the Corona (A.M. Title)
- Physical Models of Solar Prominences (U. Anzer)

4. Multi-scale Coronal Structures and Links to Photospheric Magnetic Field

- A Search for Relationships Between Sub-Photospheric Flows and Large-Scale Magnetic and Coronal Structures (B. Hindman)
- Multi-Wavelength Observations of the Solar Corona from CORONAS-F (I.A. Zhitnik)
- Emerging Magnetic Flux and Helicity Injections into the Solar Corona (K. Kusano)
- Physics of Coronal Magnetic Loops (A.V. Stepanov)
- Evaluation of Coronal Heating Models from Yohkoh, SOHO, and TRACE Observations (M. Aschwanden)
- On the Mechanisms of Coronal Heating (V.V.Zaitsev)

5. Energy Transport, Storage and Release in the Solar Atmosphere and Corona

- Time-Distance Observations of Shear Flows in Active Regions and Their Relation to Solar Flares (J. Zhao)
- Magnetic Field Configuration in Impulsive Solar Flares Revealed with Yohkoh and Nobeyama Radioheliograph (T. Kosugi)
- Ellerman Bombs and Severny Moustaches (A. Georgakilas)
- Multi-wavelength Observations of Large-scale Shock Waves on the Sun (J.I. Khan)
- Observations of Solar Flares from CORONAS-F (J. Sylwester)
- Multi-Thermal Imaging of Solar Flares (D. Alexander)
- Magnetic Reconnection: Observations vs. Models (B.V. Somov)

6. Heliospheric Effects and Space Weather Research

- Global Structure of the Heliospheric Magnetic Field (L.A. Fisk)

– The Origin of The Fast Solar Wind (A. Gabriel)
– What Is Missing from Our Understanding of Long-Term Solar and Heliospheric Activity? (C. Schrijver)

7. Multi-Wavelength Observations of the Sun from Ground and Space

– The CORONAS Program (V.N. Oraevsky)
– The Advanced Technology Solar Telescope (S. Keil)
– The Living With a Star Program and Solar Dynamics Observatory (T.J. Hoeksema)

All correspondence concerning the preparation of proposals for IAU Symposia and Colloquia should be sent to the IAU Assistant General Secretary:

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Completed proposals for Symposia and Colloquia should be sent to the President of the relevant IAU Division or the President of a Commission or Working Group of the Executive Committee if applicable, who will forward them to the Assistant General Secretary before the deadline announced for the year in question.